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# Initial Remedial Action Plan for Expanded Bioventing System BX Service Station

## Patrick Air Force Base Florida

Prepared For

Air Force Center for Environmental Excellence
Brooks Air Force Base
San Antonio, Texas

and

45 CES/CEV
Patrick Air Force Base,
Florida

April 1995

PARSONS
ENGINEERING SCIENCE, INC.

1700 Broadway, Suite 900 • Denver, Colorado 80290

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# INITIAL REMEDIAL ACTION PLAN
# FOR EXPANDED BIOVENTING SYSTEM
# BX SERVICE STATION
# PATRICK AFB, FLORIDA

**Prepared for:**

**AIR FORCE CENTER FOR ENVIRONMENTAL EXCELLENCE**

**BROOKS AFB, TEXAS**

**AND**

**45 CES/CEV**

**PATRICK AFB, FLORIDA**

**APRIL 1995**

**Prepared by:**

**PARSONS ENGINEERING SCIENCE, INC.**

**DENVER, COLORADO**

# P.E. CERTIFICATION

The Initial Remedial Action Plan for the BX Service Station (Facility 736) located at Patrick Air Force Base (AFB), Florida has been reviewed. The Florida Department of Environmental Protection (FDEP) facility number for this site is 05/8518036, Patrick AFB, Florida.

I hereby certify that in my professional judgment, the components of this Initial Remedial Action Plan satisfy the requirements set forth in Chapter 62-770, Florida Administrative Code (FAC). This plan is intended to address soil contamination only. Groundwater remediation is not specifically addressed in this plan. The engineering design features incorporated in this plan provide reasonable assurances of achieving the soil remediation objectives stated in Chapter 62-770, FAC. To the best of my knowledge, this plan is free of errors and omissions and follows the guidelines outlined in the Petroleum Contamination Site Cleanup Criteria for Initial Remedial Actions-Alternative Procedures.

Signature

3/28/95

Date

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# ACRONYMS AND ABBREVIATIONS

| | |
|---|---|
| AFB | Air Force Base |
| AFCEE | Air Force Center for Environmental Excellence |
| bgs | Below ground surface |
| BTEX | Benzene, toluene, ethylbenzene, and xylenes |
| $CO_2$ | Carbon dioxide |
| CW | Compliance Well |
| FAC | Florida Administrative Code |
| FDEP | Florida Department of Environmental Protection |
| HVW | Horizontal venting well |
| ICE | Internal combustion engine |
| ISR | *In situ* respiration test |
| Kb | Long-term biodegradation rate |
| Ko | Oxygen utilization rate |
| mg/kg | Milligrams per kilogram |
| MP | Monitoring point |
| $O_2$ | Oxygen |
| OVM | Organic vapor meter |
| Parsons ES | Parsons Engineering Science, Inc. |
| PID | Photoionization detector |
| ppmv | Parts per million, volume per volume |
| PVC | Polyvinyl chloride |
| SCF | Standard cubic feet |
| SCFM | Standard cubic feet per minute |
| SVE | Soil vapor extraction |
| TEI | Thermo Environmental Instruments |
| TRPH | Total recoverable petroleum hydrocarbons |
| TVH | Total volatile hydrocarbons |
| UST | Underground storage tank |
| VMP | Vapor monitoring point |

# SECTION 1

# INTRODUCTION

This initial remedial action plan presents the scope for an expanded bioventing system for *in situ* treatment of fuel-contaminated soils at the BX Service Station at Patrick Air Force Base (AFB), Florida. The proposed expanded system activities will be performed by Parsons Engineering Science, Inc. (Parsons ES) for the Air Force Center for Environmental Excellence (AFCEE) Technology Transfer Division (ERT) under contract F41624-92-D-8036, 0017. The primary objectives of the system upgrade are:

- To supply oxygen throughout the contaminated soil volume;
- To continue *in situ* remediation of fuel-contaminated soils by stimulation with oxygen-rich soil gas; and
- To sustain *in situ* biodegradation until fuel-contaminated soils within the unsaturated zone are remediated to regulatorily approved standards.

A one-year bioventing pilot test was performed at this site to determine if *in situ* bioventing would be a feasible cleanup technology for the fuel-contaminated soils within the unsaturated zone in the source area. The area of oxygen influence during the pilot test was limited to approximately a 30-foot radius around the horizontal venting well (HVW), at a low 10 standard cubic foot per minute (SCFM) air injection flow rate.

Following the one-year pilot test, soil and soil gas data confirmed significant contaminant removal in the entire pilot test area. Based on laboratory results from soil and soil gas samples taken from the most contaminated areas, a reduction in soil gas concentrations of total volatile hydrocarbons (TVH) and total benzene, toluene, ethylbenzene, and xylenes (BTEX) was 99.9 percent at monitoring point (MP) A; and a reduction in soil concentrations of total recoverable petroleum hydrocarbons (TRPH) and total BTEX of 97 percent and 100 percent respectively, near the HVW location. The success of bioventing at this site supports the recommendation of an expanded bioventing system as the most economical approach of remediating the remaining fuel-contaminated soils within the source area.

Parsons ES also completed a comprehensive study of the natural biodegradation of groundwater contamination on this site. A secondary purpose of this initial remedial action is to continue the removal of fuel residuals which act as a source of this groundwater contamination and to enhance the natural BTEX removal process occurring in the groundwater.

Pilot test data have been used to design the expanded remediation system and to estimate the time required to remediate soils to regulatory standards. The expanded system will employ three horizontal air injection vent wells (HVWs), one installed during the initial one-year pilot test, and two additional HVWs to provide oxygen throughout the remaining unsaturated fuel-contaminated soils area.

This document is divided into six sections including this introduction. Section 2 discusses site background. Section 3 provides the results of the one-year pilot test conducted at the BX service station. Section 4 identifies the areas to be influenced by the system upgrade; provides construction details on the expanded system; and recommends a proven, cost-effective approach for the remediation of the remaining fuel-contaminated soils within the source area at the site. Section 5 provides key points of contact at Patrick AFB, AFCEE, and Parsons ES; and Section 6 provides the references cited in this document.

# SECTION 2

# SITE BACKGROUND

## 2.1 HISTORY OF THE BX SERVICE STATION

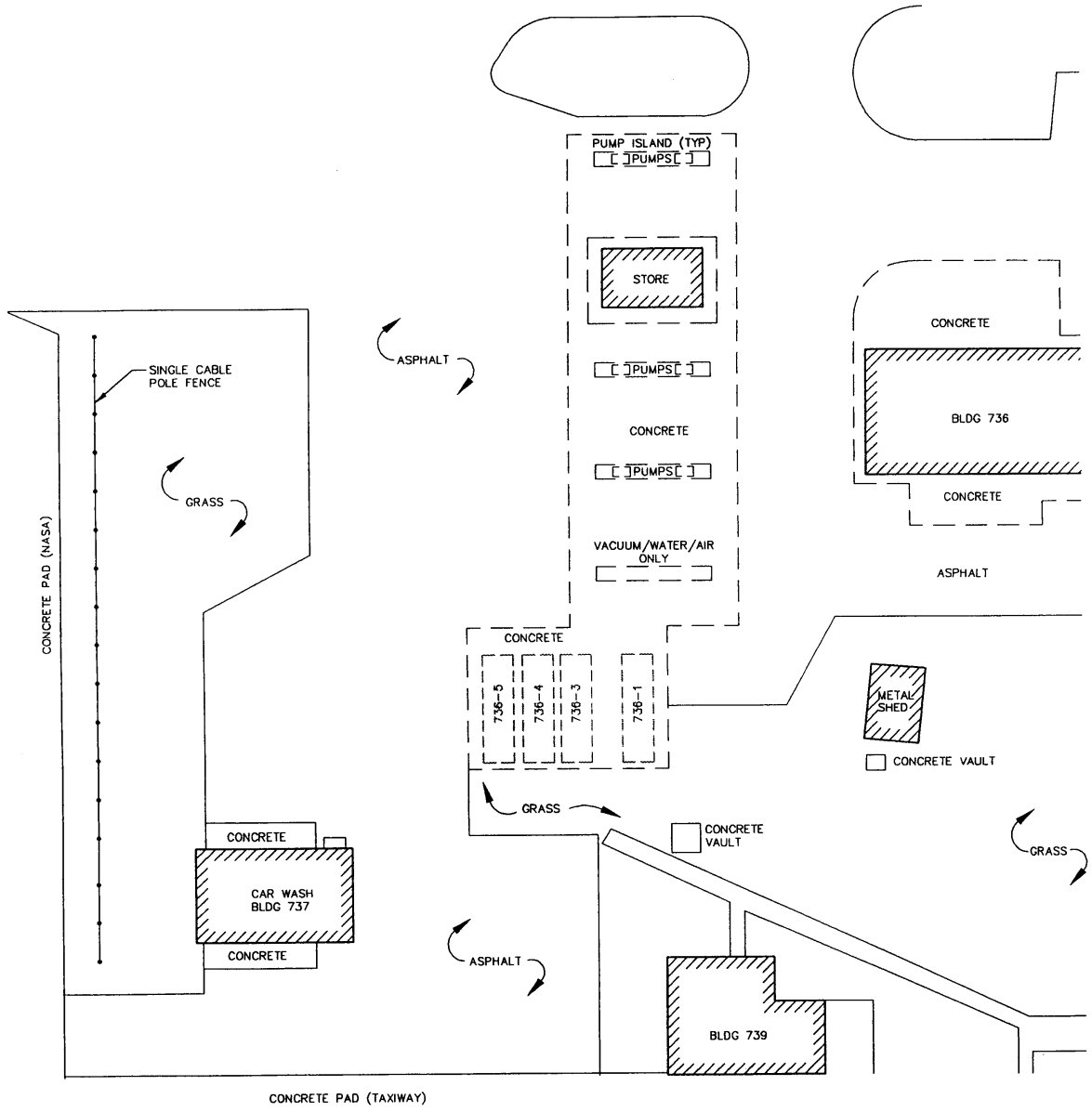
The BX Service Station (Figure 2.1) has been in service since 1954. In 1973, four 5,000-gallon gasoline underground storage tanks (USTs) and one 4,000-gallon diesel UST were abandoned and filled with sand. In 1993, they were removed by O'Brien & Gere Engineers. In 1975, five 10,000-gallon fiberglass USTs were emplaced, one of which was removed in 1986 because of leaks. Leaking fuel lines (discovered in 1985) are estimated to have lost approximately 700 gallons of gasoline (O'Brien & Gere, 1990).

A soil headspace analyses investigation was conducted around the pump islands and UST area by $CH_2MHill$ in March 1994. The soil headspace screening identified excessively contaminated soil in the immediate vicinity of the UST and pump island areas shown in Figure 2.2. The soil headspace screening results also provide a reasonable delineation of the existing soil contamination at this site.

A soil gas survey was conducted by Parsons ES in the same area on December 26, 1994. Results from the survey indicated that the extent of remaining unsaturated soil contamination appears to be localized around the existing pump islands and USTs. Each soil sampling location was screened for the presence of oxygen ($O_2$), carbon dioxide ($CO_2$), and TVH using hand-held instrumentation. The soil gas sampling results, shown on Figure 2.3, confirmed the presence of soil contamination as identified during the earlier headspace sampling performed by $CH_2MHill$ in March 1994. The soil gas results also identified the areas where biodegradation in fuel-contaminated soil has depleted oxygen ($<5$ percent) (Figure 2.3). Due to the lack of $O_2$ in areas outside of the bioventing pilot system radius of influence, *in situ* biodegradation in these fuel-contaminated soils has been significantly limited.

## 2.2 GEOLOGY OF THE BX SERVICE STATION

Because the bioventing technology is applied to the unsaturated soils, this section will address primarily soils above the shallow aquifer. Soils at this site, to a depth of 25 feet below ground surface (bgs), consist of predominantly unconsolidated, poorly to moderately well sorted, fine-to-coarse-grained quartz sand with up to 40 percent shell fragments. Groundwater is encountered at seasonally fluctuating depths of approximately 4 to 6 feet. The generally homogeneous, sandy material at this site is well suited to bioventing treatment, as was demonstrated during the initial one-year bioventing pilot test.



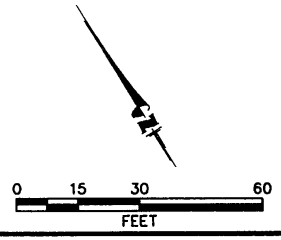




**FIGURE 2.1**

**SITE PLAN**
**BX SERVICE STATION**

Patrick AFB, Florida

PARSONS ENGINEERING SCIENCE, INC.
Denver, Colorado

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## PHASE I SOIL HEADSPACE RESULTS FROM $CH_2MHILL$–MARCH 1994 INVESTIGATION AT BX SERVICE STATION SITE, PATRICK AFB, FLORIDA

| LOCATION | DEPTH a/ (IN FEET) | TEI–OVM b/ (PPMV) | LOCATION | DEPTH a/ (IN FEET) | TEI–OVM b/ (PPMV) |
|---|---|---|---|---|---|
| SB1 | 5 | 380 c/ | SB14 | 5 | 1,161 |
| SB2 | 5 | 0 | SB15 | 5 | 229 |
| SB3 | 2 | 9 | SB16 | 5 | 74 |
| SB4 | 5 | 331 | SB17 | 5 | 322 |
| SB5 | 2 | 32 | SB18 | 5 | 234 |
| SB6 | 4 | 1,672 | SB19 | 5 | 0 |
| SB7 | 5 | 1,166 | SB20 | 5 | 3,244 |
| SB8 | 5 | 308 | SB21 | 5 | 2,396 |
| SB9 | 5 | 1,262 | SB22 | 4 | 0 |
| SB10 | 2 | 1,489 | SB23 | 4 | 0 |
| SB11 | 5 | 515 | SB24 | 5 | 0 |
| SB12 | 3 | 1,199 | SB25 | 5 | 0 |
| SB13 | 4 | 769 | NOTE: WATER TABLE ENCOUNTERED AT APPROXIMATELY 6 FEET BELOW GROUND SURFACE | | |

## SUPPLEMENTAL SOIL HEADSPACE SAMPLING RESULTS FROM PARSONS ENGINEERING SCIENCE MAY 1995 INVESTIGATION AT THE BX SERVICE STATION SITE, PATRICK AFB, FLORIDA

| LOCATION | DEPTH a/ (IN FEET) | PHOTOVAC–MICROTIP d/ (PPMV) |
|---|---|---|
| SB26 | 4 | 0 |
| SB27 | 4 | 0 |
| SB28 | 1 | 1,000 |
| SB29 | 4 | 15 |
| SB30 | 4 | 12 |
| SB31 | 4 | 300 |
| SB32 | 4 | 98 |
| NOTE: WATER TABLE ENCOUNTERED AT APPROXIMATELY 5 FEET BELOW GROUND SURFACE | | |

a/ SAMPLING DEPTH REFLECTS THE ZONE WITH THE HIGHEST TOTAL VOLATILE HYDROCARBONS CONCENTRATION ENCOUNTERED DURING SAMPLING.

b/ THERMO ENVIRONMENTAL INSTRUMENT (TEI) ORGANIC VAPOR METER (OVM)–MODEL 580 SERIES; READINGS ARE IN PARTS PER MILLION, VOLUME PER VOLUME (PPMV).

c/ PPMV CONCENTRATION EQUIVALENT TO EXCESSIVELY CONTAMINATED SOIL PER FLORIDA DEPARTMENT of ENVIRONMENTAL PROTECTION IS 500 ppmv USING THE TEI–OVM AT THE 1.8:1 CORRECTION FACTOR.

d/ PPMV CONCENTRATION EQUIVALENT TO EXCESSIVELY CONTAMINATED SOIL PER FLORIDA DEPARTMENT of ENVIRONMENTAL PROTECTION IS 200 ppmv USING THE PHOTOVAC–MICROTIP, PHOTOIONIZATION DETECTOR (PID) APPROVED CORRELATION FOR UNLEADED GASOLINE.

△8 SOIL HEADSPACE SAMPLING LOCATIONS
SOURCE: $CH_2MHILL$, MARCH 1994 HAZWRAP TECHNICAL MEMORANDUM.

(30) SUPPLEMENTAL SOIL HEADSPACE SAMPLING LOCATIONS

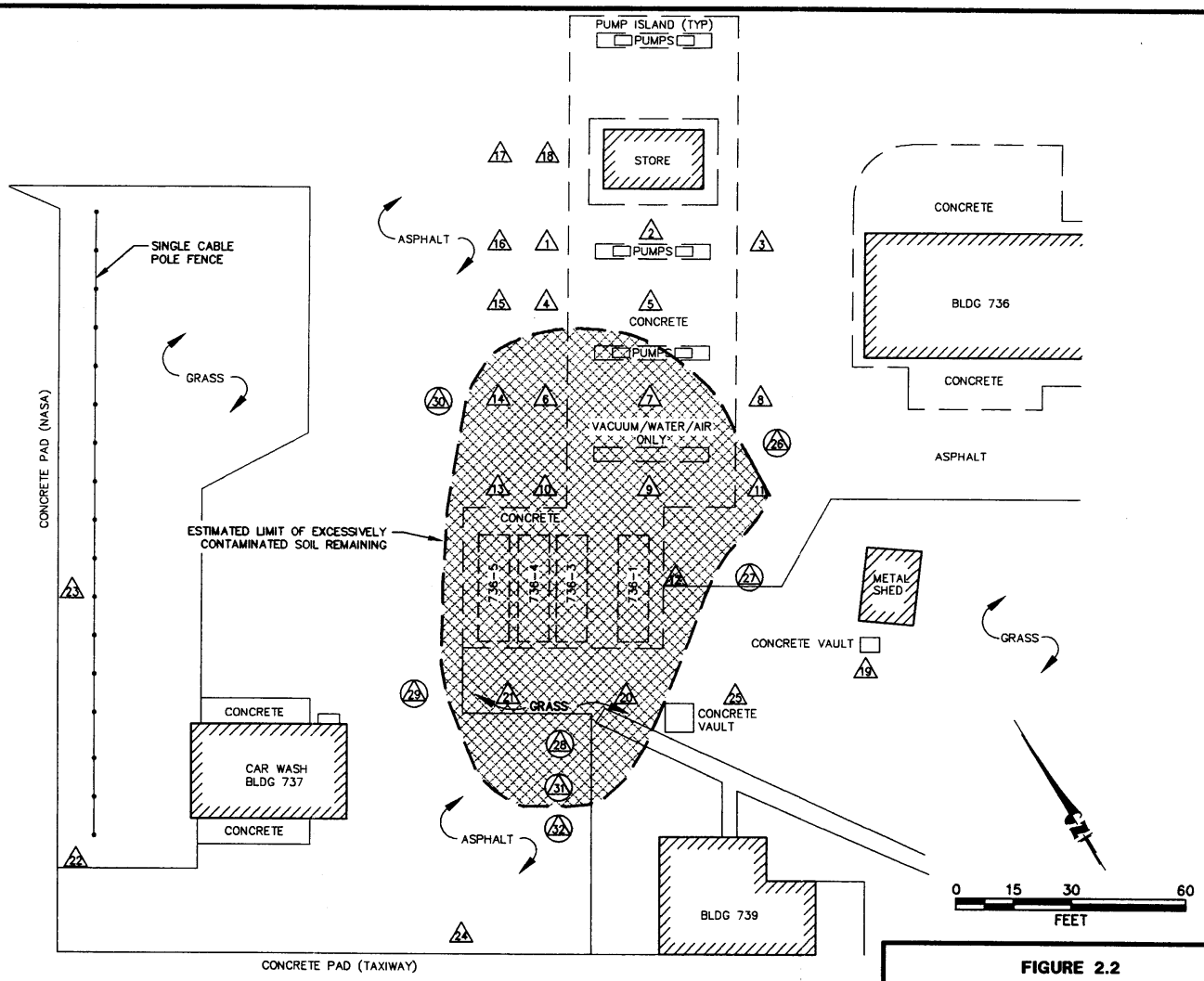


**FIGURE 2.2**

**PHASE I INVESTIGATION SOIL HEADSPACE RESULTS BX SERVICE STATION**

Patrick AFB, Florida

PARSONS ENGINEERING SCIENCE, INC.
Denver, Colorado

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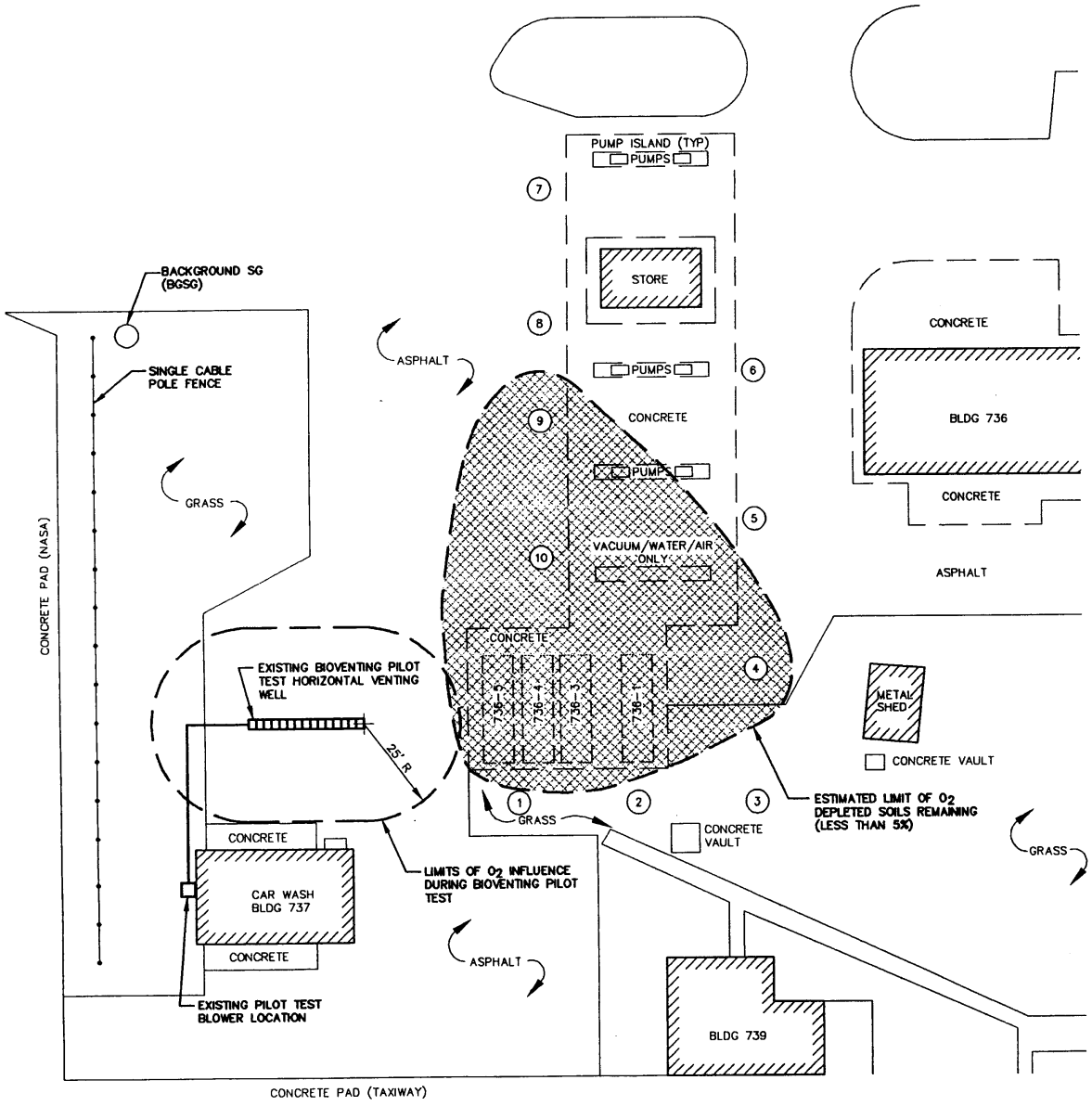


SOIL GAS SAMPLING RESULTS FROM
PARSONS ENGINEERING SCIENCE–DECEMBER 26, 1994
INVESTIGATION AT
BX SERVICE STATION SITE, PATRICK AFB, FLORIDA

| LOCATION | DEPTH a/ (IN FEET) | GASTECH & TVH (PPMV) c/ | $O_2$ (%) | $CO_2$ (%) |
|---|---|---|---|---|
| SG1 | 3 | 500 | 5.2 | 11.0 |
| SG2 | 3 | 200 | 18.8 | 2.7 |
| SG3 | 3 | 170 | 19.5 | 1.5 |
| SG4 | 3 | 600 | 3.7 | 11.3 |
| SG5 | 3 | 500 | 8.3 | 8.8 |
| SG6 | 3 | 400 | 14.2 | 4.9 |
| SG7 | 3 | 330 | 9.1 | 11.5 |
| SG8 | 3 | 320 | 11.0 | 9.2 |
| SG9 | 3 | 600 | 3.8 | 13.2 |
| SG10 | 3 | 9,500 | 0.0 | 15.0 |
| BGSG b/ | 3 | 60 | 20.5 | 0.8 |
| | | | | |

a/ ALL SOIL GAS SAMPLES TAKEN FROM 3 FEET BELOW GROUND SURFACE; WATER TABLE AT APPROXIMATELY 4 FEET BELOW GROUND SURFACE

b/ BACKGROUND SOIL GAS MONITORNIG POINT (NOT AFFECTED BY PETROLEUM HYDROCARBON CONTAMINATION)

c/ PPMV = PARTS PER MILLION, VOLUME PER VOLUME

(7) SOIL GAS SAMPLING LOCATIONS

**FIGURE 2.3**

**SOIL GAS SAMPLING RESULTS FROM DECEMBER 26, 1994 INVESTIGATION AT THE BX SERVICE STATION SITE**

Patrick AFB, Florida

PARSONS ENGINEERING SCIENCE, INC.

Denver, Colorado

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## 2.3 SITE CONTAMINANTS

Soil contaminants at the BX Service Station are gasoline-related petroleum hydrocarbons. Soil samples collected from a Phase II assessment in 1990 (O'Brien & Gere, 1990) showed TRPH concentrations ranging from 37 mg/kg to 386 mg/kg. Soil samples collected during the installation of the initial bioventing pilot test system in March 1993 ranged from 11 milligrams per kilogram (mg/kg) to 2,730 mg/kg of TRPH. The pilot system was purposefully located in the most contaminated soils in order to fully evaluate the effectiveness of bioventing at this site.

Additional soil headspace sampling conducted by $CH_2MHill$ in March 1994 in the pump islands and UST area also identified some localized unsaturated "excessively" contaminated soil using a portable hand-held organic vapor meter (OVM) ($CH_2MHill$, 1994). The soil headspace sampling was performed at 25 locations in accordance with the Florida Department of Environmental Protection (FDEP) soil screening guidelines for the headspace analysis method prescribed in Chapter 17-770.200 (2), Florida Administrative Code (FAC). The soil samples were screened for contamination using the Thermo Environmental Instruments, Inc. (TEI) OVM Model 580 equipped with a photoionization detector (PID). The correlating concentration of "excessively" contaminated soil using the TEI-OVM headspace method on gasoline-contaminated soil is 500 parts per million, volume per volume (ppmv), when the instrument has been calibrated using a response factor of 1.8:1 as stated by FDEP in the acceptance letter of June 26, 1991.

Based on the soil and soil gas sampling conducted at this site, the remaining soil contamination appears to be limited to the area immediately adjacent to the pump islands and UST locations. The soil vapor headspace readings collected at this site ranged from 0 to 3,244 ppmv during the March 1994 sampling performed by $CH_2MHill$. Figure 2.2 shows the estimated limits of "excessively" contaminated soil still remaining outside the radius of influence of the existing pilot-scale bioventing system. The proposed upgrade to the bioventing pilot system is designed to provide the necessary oxygen and stimulate *in situ* biodegradation throughout the remaining soil contamination.

# SECTION 3

# BIOVENTING PILOT TEST RESULTS

The objectives of the initial bioventing pilot test were to:

- Assess the potential for supplying oxygen throughout the contaminated soil depth;
- To determine the rate at which indigenous microorganisms will degrade fuel when stimulated by oxygen-rich soil gas at this site; and
- To evaluate the potential for sustaining these rates of biodegradation until fuel contamination is remediated below regulatorily approved standards.

If bioventing proved to be a feasible technology for this site, the pilot test data would then be used to design a full-scale remediation system and to estimate the time required to remediate the soils to regulatory standards.

## 3.1 TEST CONFIGURATION

An initial soil gas survey was conducted at the BX Service Station Site on January 12, 1993, to select the optimum location for the pilot test. Based on the survey data, the central horizontal vent well was located in the area showing the most oxygen depletion (<2 percent), with high TVPH concentrations (>10,000 ppmv), and elevated $CO_2$ (>12 percent). Results of the soil gas survey (Table 3.1 and Figure 3.1) identified the optimum location for the HVW as between soil gas sampling points SG-10 and SG-13. Figure 3.2 shows locations of the HVW, vapor monitoring points (VMPs), and blower. The VMPs were installed to monitor the *in situ* biodegradation rates, as well as to determine the radius of oxygen influence of the HVW.

## 3.2 PHASE ONE - SOIL VAPOR EXTRACTION

Initial laboratory soil gas sample results at the test site ranged from 38,000 to 100,000 ppmv for TVH within the pilot study area [Engineering-Science, Inc. (Now Parsons ES), 1993].

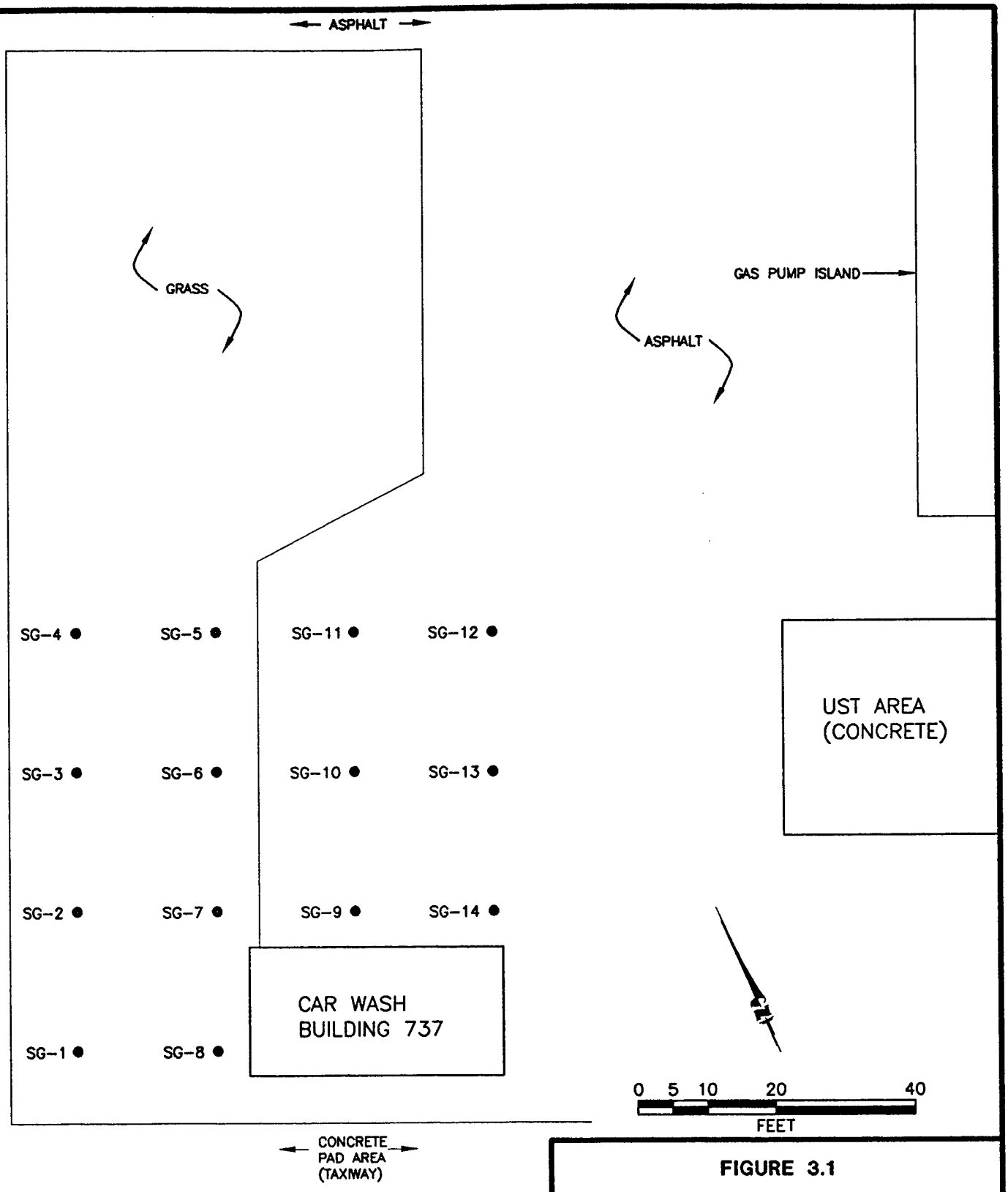
Due to the high initial TVH concentrations encountered at this site, a decision was made to perform soil vapor extraction (SVE) followed by air injection bioventing. A reduction in soil vapor concentrations was required to reduce the potential for hazardous vapor migration. In order to achieve the FDEP's requirement of greater than 99 percent destruction of the extracted vapor stream during the initial three months of SVE operation, an internal combustion engine (ICE) was selected for vapor treatment. The ICE was capable of achieving >99 percent removal without the need

# TABLE 3.1
# SOIL GAS SURVEY RESULTS
# JANUARY 12, 1993
# BX SERVICE STATION
# PATRICK AIR FORCE BASE, FLORIDA

| Soil Gas Test Point | DEPTH (feet bgs)[a/] | $O_2$ (percent) | $CO_2$ (percent) | TVPH Concentration (ppmv)[b/] | Remarks |
|---|---|---|---|---|---|
| SG-1 | 1.5 | 20.5 | 0.8 | 30 | Water Table |
| | 3.0 | 20.5 | 0.8 | 32 | ~3.5-4.0 bgs |
| SG-2 | 1.5 | 20.0 | 0.9 | 35 | |
| | 3.0 | 20.0 | 1.0 | 45 | |
| SG-3 | 1.5 | 20.0 | 0.8 | 38 | |
| | 3.0 | 20.0 | 0.8 | 50 | |
| SG-4 | 1.5 | 20.5 | 0.5 | 42 | |
| | 3.0 | 20.5 | 0.8 | 45 | |
| SG-5 | 1.5 | 17.0 | 3.0 | 72 | |
| | 3.0 | 16.5 | 3.2 | 82 | |
| SG-6 | 1.5 | 14.5 | 2.5 | 75 | |
| | 3.0 | 9.5 | 4.5 | 90 | |
| SG-7 | 1.5 | 4.0 | 10.0 | 96 | |
| | 3.0 | 0.0 | 12.5 | 3,500 | |
| SG-8 | 1.5 | 0.0 | 13.0 | 9,000 | |
| | 3.0 | 0.0 | 13.0 | >10,000 | |
| SG-9 | 1.5 | 0.0 | 12.0 | >10,000 | |
| | 3.0 | 0.0 | 12.0 | >10,000 | |
| SG-10 | 1.5 | 0.0 | 12.0 | >10,000 | |
| | 3.0 | 0.0 | 12.0 | >10,000 | |
| SG-11 | 1.5 | 6.0 | 9.5 | 70 | |
| | 3.0 | 4.0 | 10.5 | 90 | |
| SG-12 | 1.5 | 0.0 | 13.0 | 4,000 | |
| | 3.0 | 0.0 | 13.0 | 4,400 | |
| SG-13 | 1.5 | 0.0 | 12.0 | 10,000 | |
| | 3.0 | 0.0 | 12.0 | 10,000 | |
| SG-14 | 1.5 | 0.0 | 11.0 | 6,500 | |
| | 3.0 | 0.0 | 11.0 | 10,000 | |

a/ bgs = Below ground surface.

b/ TVPH = Total volatile petroleum hydrocarbons; ppmv = parts per million, volume per volume.




LEGEND

SG-1 ● SOIL GAS SAMPLING LOCATION

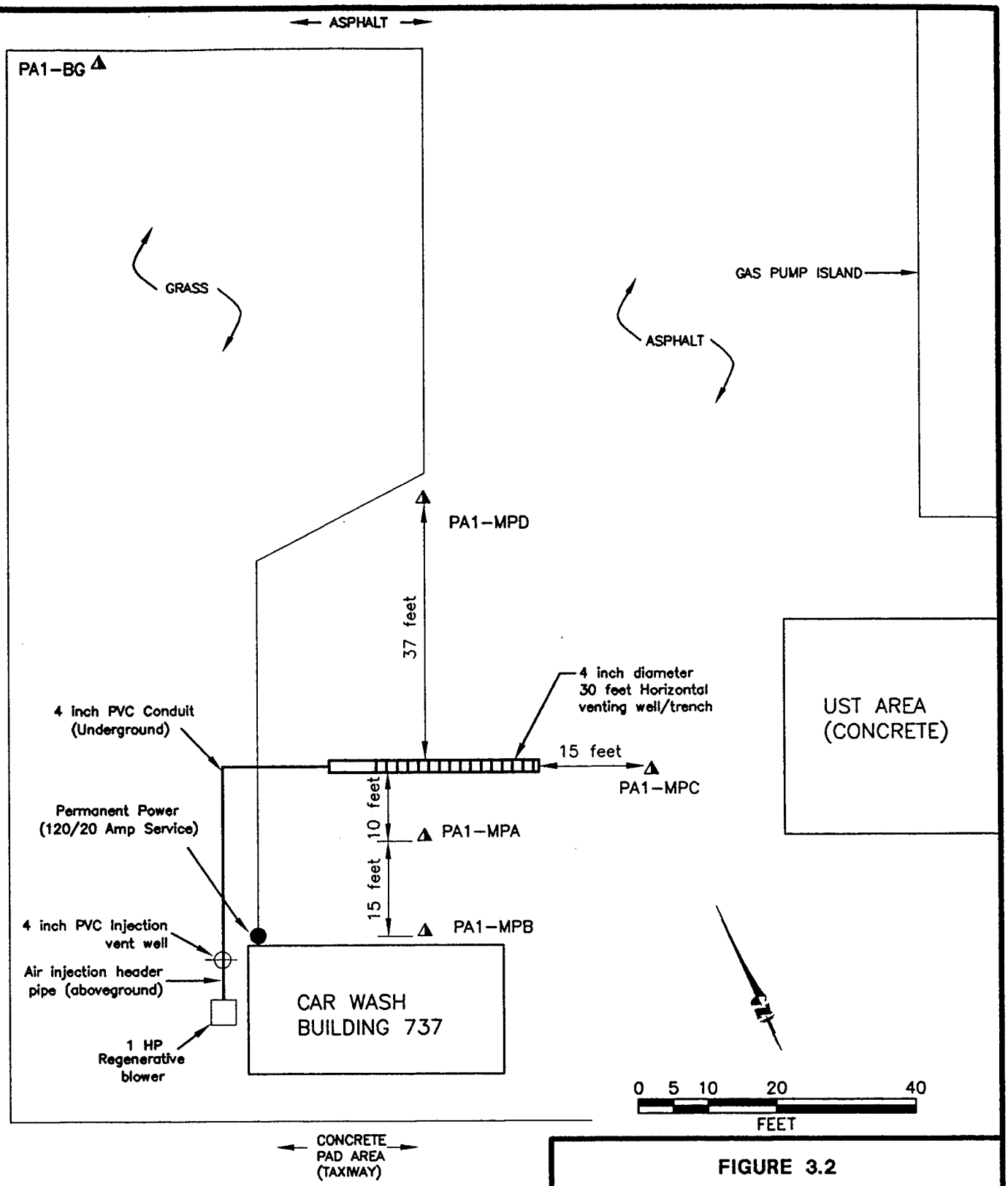
**FIGURE 3.1**

**SOIL GAS SAMPLING LOCATIONS JANUARY 12, 1993 BX SERVICE STATION**

Patrick AFB, Florida

PARSONS ENGINEERING SCIENCE, INC.

Denver, Colorado

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PA1-MPA ▲ Permanent soil vapor/pressure monitoring point.

**FIGURE 3.2**

**AS-BUILT HORIZONTAL VENTING WELL, VAPOR MONITORING POINTS, AND BLOWER LOCATIONS FOR INITIAL BIOVENTING PILOT TEST BX SERVICE STATION**

Patrick AFB, Florida

PARSONS ENGINEERING SCIENCE, INC.

Denver, Colorado

for a secondary treatment technology such as granular activated carbon (GAC), resulting in the lowest overall cost when compared to alternative technologies.

An average flow rate of 80 SCFM was used during the initial three months of vapor extraction. Based on laboratory results during the ICE operation, extracted soil gas concentrations from the HVW were reduced from 26,800 to 1,600 ppmv TVH, and 230 to 44 ppmv total BTEX. Figure 3.3 shows the reduction of BTEX and TVH over total standard cubic feet (SCF) treated based on laboratory results from sampling events throughout the extraction period.

## 3.3 PHASE TWO - AIR INJECTION BIOVENTING

Following removal and destruction of the majority of TVH present in the study area, a decision was made to begin air injection bioventing to remove the remaining fuel residuals. After the initial three months of SVE, the potential for vapor migration had been significantly reduced or eliminated. The air injection flow rate was reduced to a maximum of 10 SCFM in order to minimize any potential for vapor migration while providing oxygen to the study area.

### 3.3.1 System Operation

Upon initial startup of the air injection system at 10 SCFM, the $O_2$ influence was monitored at VMP-B, 25 feet from the HVW. The initial $O_2$ level at this point was 1.8 percent. After 24 hours at the 10 SCFM injection rate, the $O_2$ content at VMP-B had risen to 18.5 percent. Since sufficient $O_2$ was being supplied within this 25-foot radius of influence, the air injection flow rate of 10 SCFM was maintained throughout the remainder of the one-year bioventing pilot test study. Weekly system checks were conducted to ensure consistent system operation and performance.

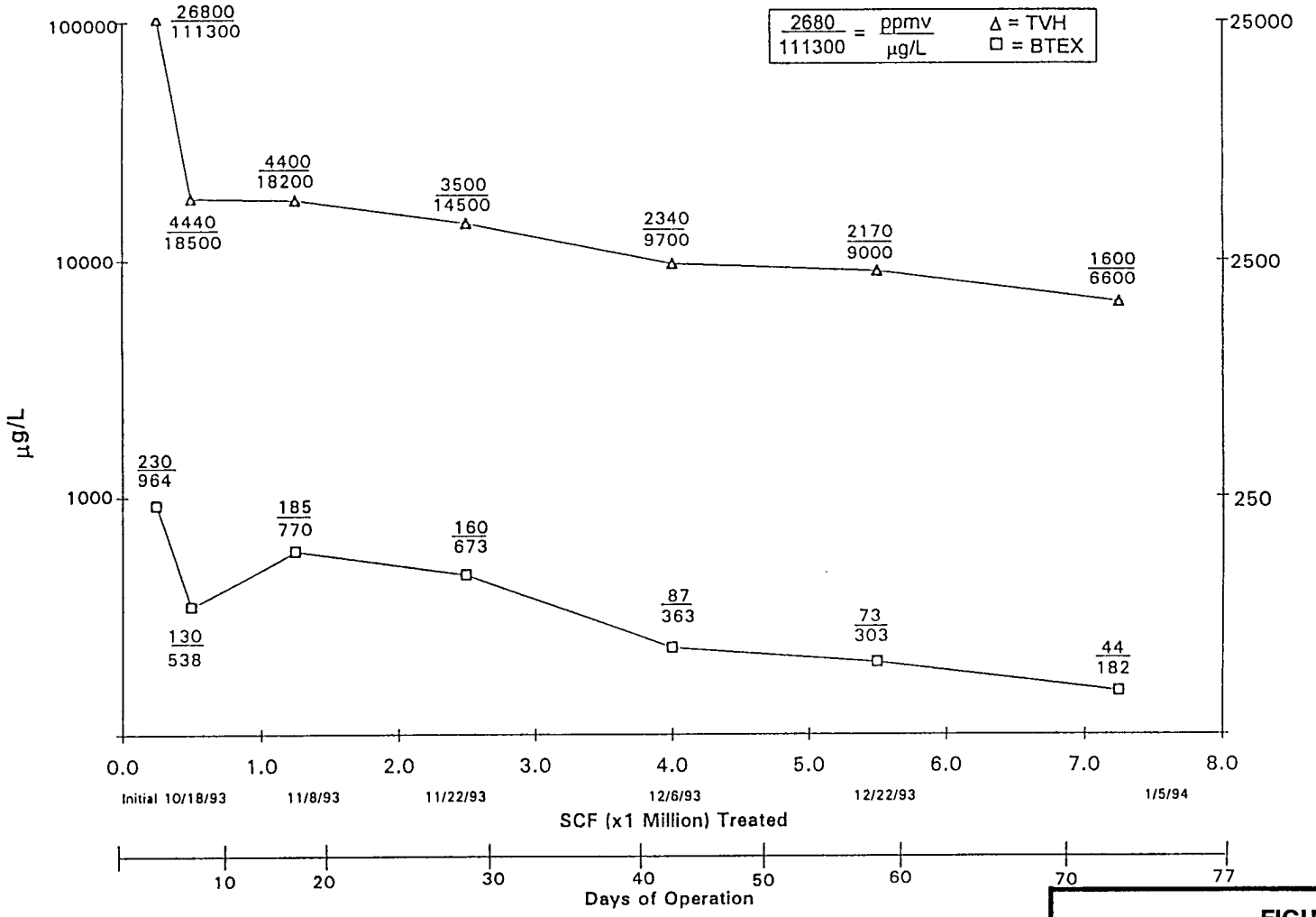
### 3.3.2 *In Situ* Biodegradation Rates

Initial, 6-month and 12-month *in situ* respiration tests and initial and one-year final soil sampling events were completed as part of the bioventing pilot test. Table 3.2 shows the estimated fuel degradation rates in milligrams of TRPH per kilogram of soil per year at MPA, MPB, and MPC locations, based on the initial, 6-month and one-year respiration tests.

Initial biodegradation rates ranged from 840 to 970 mg/kg/year. After 6 months of $O_2$ influence, rates increased to 850 to 1,400 mg/kg/year. At the end of the one-year testing period, rates had significantly declined. The decline in rates at the end of the testing period is due to the reduction of fuel (substrate for bacteria) remaining in the soils.

### 3.3.3 One-Year Soil and Soil Gas Sampling Results

Upon completion of the one-year study, final soil and soil gas samples were collected from the initial sample locations. A final soil gas sample from the HVW could not be collected due to a seasonally high water table and the presence of water within the piping. Table 3.3 shows the initial and one-year soil and soil gas laboratory sampling results from the HVW, MPA, and MPC locations. As shown on Table 3.3,




BTEX = BENZENE, TOLUENE, ETHYLBENZENE, AND XYLENE

TVH = TOTAL VOLATILE HYDROCARBONS

ppmv = PARTS PER MILLION, VOLUME PER VOLUME

TVH = TOTAL VOLATILE HYDROCARBONS

µg/L = MICROGRAM PER LITER

SCF = STANDARD CUBIC FEET

**FIGURE 3.3**

**BTEX AND TVH REDUCTION DURING VAPOR EXTRACTION BX SERVICE STATION**

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PARSONS ENGINEERING SCIENCE, INC.

Denver, Colorado

# TABLE 3.2
# RESPIRATION AND DEGRADATION RATES
# BX SERVICE STATION
# PATRICK AIR FORCE BASE, FLORIDA

| Location-Depth (feet below ground surface) | Initial | | | 6-Month [e/] | | | One-Year | | |
|---|---|---|---|---|---|---|---|---|---|
| | $K_o$ [a/] ($\%O_2$/min) [b/] | Degradation Rate (mg/kg/year)[c/] | Soil Temperature (°C) [d/] | $K_o$ ($\%O_2$/min) | Degradation Rate (mg/kg/year) | Soil Temperature (°C) | $K_o$ ($\%O_2$/min) | Degradation Rate (mg/kg/year) | Soil Temperature (°C) |
| MPA-3.5 | 0.0028 | 940 | 23 | 0.0032 | 970 | 33 | 0.00049 | 130 | 24 |
| MPB-3.5 | 0.0025 | 840 | NS [f/] | 0.0045 | 1400 | NS | 0.00059 | 150 | NS |
| MPC-3.5 | 0.0027 | 970 | 23 | 0.0027 | 850 | 33 | 0.00033 | 92 | 23 |

a/ $K_o$ = Oxygen utilization rate.
b/ % $O_2$/min = Percent oxygen per minute.
c/ Milligrams of hydrocarbons per kilogram of soil per year.
d/ °C = Degrees Celsius
e/ Assumes moisture content of the soil is average of initial and final moistures.
f/ NS = Not sampled.

# TABLE 3.3
# INITIAL AND ONE-YEAR SOIL AND SOIL GAS ANALYTICAL RESULTS
# BX SERVICE STATION
# PATRICK AIR FORCE BASE, FLORIDA

| Analyte (Units) [a/] | Sample Locations-Depth (feet below ground surface) | | | | | |
|---|---|---|---|---|---|---|
| | HVW-4.0 | | MPA-3.5 | | MPC-3.5 | |
| Soil Gas Hydrocarbons | Initial [b/] | One-Year [c/] | Initial | One-Year | Initial | One-Year |
| TVH (ppmv) | 47,000 | NS [d/] | 100,000 | 6.9 | 38,000 | 1.7 |
| Benzene (ppmv) | <2.2 | NS | <5.3 | 0.033 | <2.1 | 0.02 |
| Toluene (ppmv) | 15 | NS | 110 | 0.003 | 8.3 | <0.002 |
| Ethylbenzene (ppmv) | 14 | NS | 46 | 0.008 | 12 | <0.002 |
| Xylenes (ppmv) | 200 | NS | 310 | 0.46 | 83 | <0.002 |
| | HVW-4.0 | | MPA-3.5 | | MPC-3.5 | |
| Soil Hydrocarbons | Initial [e/] | One-Year [f/] | Initial | One-Year | Initial | One-Year |
| TRPH (mg/kg) | 2,730 | 81.9 | 11 | 50.8 | 60 | 57.6 |
| Benzene (mg/kg) | <14 | <0.05 | <6.2 | <0.05 | <0.31 | 0.13 |
| Toluene (mg/kg) | 54 | <0.05 | 23 | <0.05 | <0.36 | 0.15 |
| Ethylbenzene (mg/kg) | 260 | <0.05 | 320 | <0.05 | <0.26 | 0.16 |
| Xylenes (mg/kg) | 2,600 | <0.099 | 140 | <0.1 | 5.7 | 0.49 |
| Moisture (%) | 15 | 10 | 2.9 | 6.7 | 1.9 | 6 |

a/ TVH = Total volatile hydrocarbons: ppmv = parts per million, volume per volume;
TRPH = Total recoverable petroleum hydrocarbons; mg/kg = milligrams per kilogram.

b/ Initial soil gas samples collected on April 16, 1993.

c/ Final soil gas samples collected on December 20, 1994.

d/ NS = Not sampled.

e/ Initial soil samples collected on March 9,,1993.

f/ Final soil samples collected on December 27, 1994.

initial soil gas hydrocarbons and soil hydrocarbons (TRPH and BTEX) were significantly reduced. The average reduction in soil gas hydrocarbons was 99.9 percent for both BTEX and TVH. The average reduction in soil hydrocarbons was 93 percent for TRPH and 98 percent for total BTEX constituents.

### 3.3.4 Recommendation for Full-Scale Bioventing

Based on the excellent one-year testing results, AFCEE has provided funding and contractual support for an expanded bioventing system at the BX Service Station site. AFCEE has retained Parsons ES to continue bioventing services at Patrick AFB and to complete the installation of an expanded bioventing system as soon as possible. Section 4 provides details on the design, construction and operation of the expanded system.

# SECTION 4

# EXPANDED BIOVENTING SYSTEM

The purpose of the expanded bioventing system is to provide oxygen and to stimulate aerobic biodegradation of the remaining soil contamination present at the BX Service Station site. Based upon the most recent soil headspace sampling at the site, two additional air injection HVWs, along with the existing pilot HVW, should be capable of providing oxygen to all remaining unsaturated soil contamination at the site.

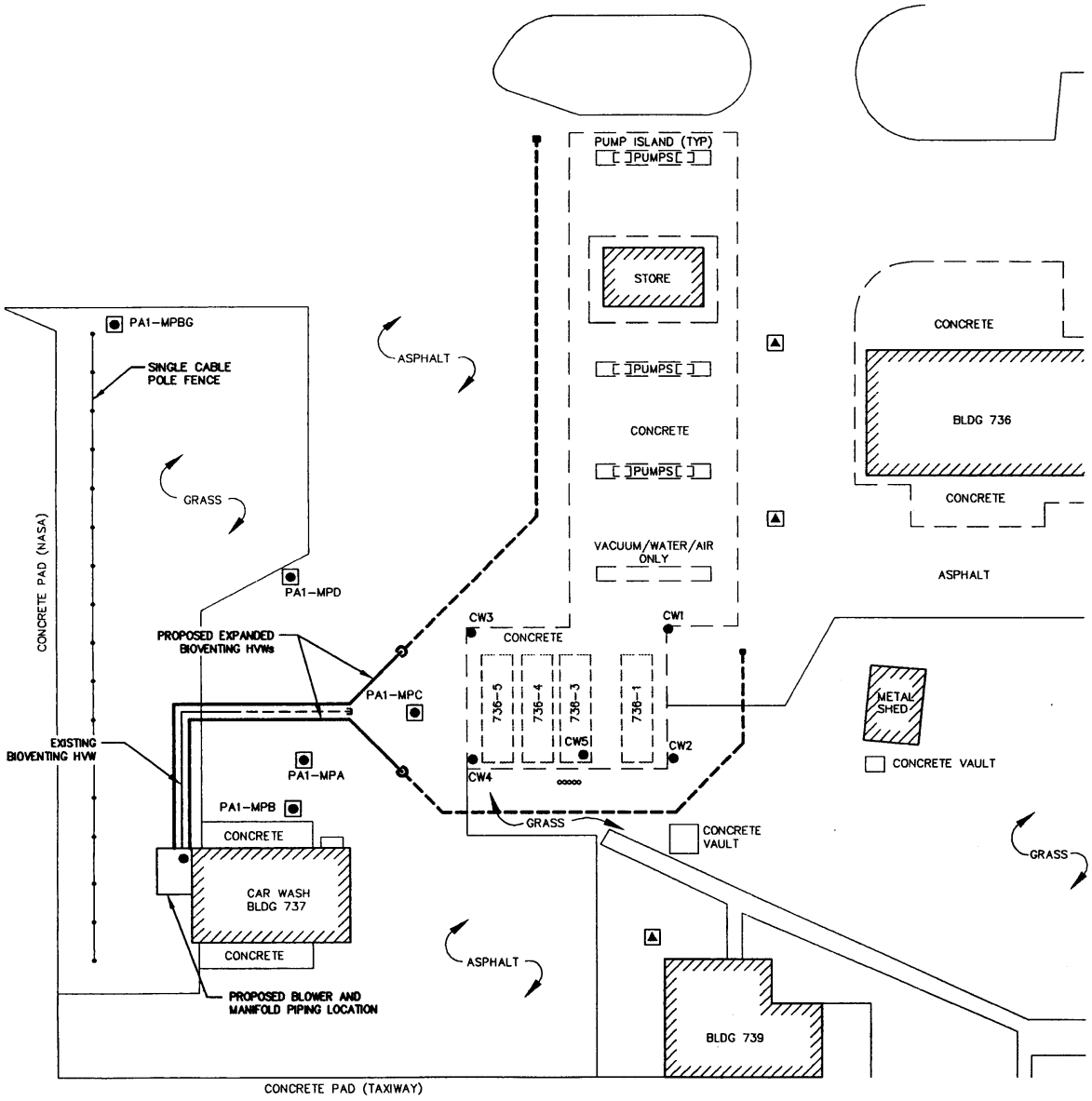
## 4.1 OBJECTIVE

Following its implementation, the primary objectives of the expanded bioventing system will be to:

- Optimize the system in order to fully influence the contaminated area;
- Monitor the system to ensure continuous operation;
- Reduce the existing contaminant levels to acceptable regulatory cleanup criteria;
- By removing the source, eliminate the potential for contamination to continue to impact ground water quality at this site; and
- Provide the most cost-effective remediation alternative for this site, while eliminating unnecessary impacts to the operations of this active fueling facility.

## 4.2 SYSTEM DESIGN

The proposed upgrade to the existing bioventing system will incorporate the addition of two HVWs. One HVW will be installed along the western side of the existing pump islands in the area of highest soil contamination. The second HVW will be installed along the southern side of the existing USTs in another area of significant soil contamination. Figure 4.1 shows the site layout including the existing bioventing system, blower location, and the proposed HVW and monitoring point locations. Figures 4.2 and 4.3 depict locations and cross-sections of the proposed HVWs including construction details, placement of proposed HVW piping in relationship to existing system piping, and a construction detail and cross-section of the vapor monitoring points.




LEGEND

- PROPOSED HVW-SOLID, 1 1/2 inch DIAMETER SCH 80 PVC, HEADER PIPE
- PROPOSED HVW-SCREENED INTERVAL, 4 inch DIAMETER SCH 40 PVC, WITH 0.30 inch SLOTTED SCREEN
- PA1-MPA — EXISTING PERMANENT VAPOR MONITORING POINT
- CW-1 — EXISTING COMPLIANCE MONITORING WELL FOR UNDERGROUND STORAGE TANK AREA
- PROPOSED VAPOR MONITORING POINTS FOR THE EXPANDED BIOVENTING SYSTEM
- HVW — HORIZONTAL VENTING WELL

0 15 30 60
FEET

**FIGURE 4.1**

**EXISTING AND PROPOSED HORIZONTAL VENTING WELL AND BLOWER LOCATION FOR THE BX SERVICE STATION SITE**

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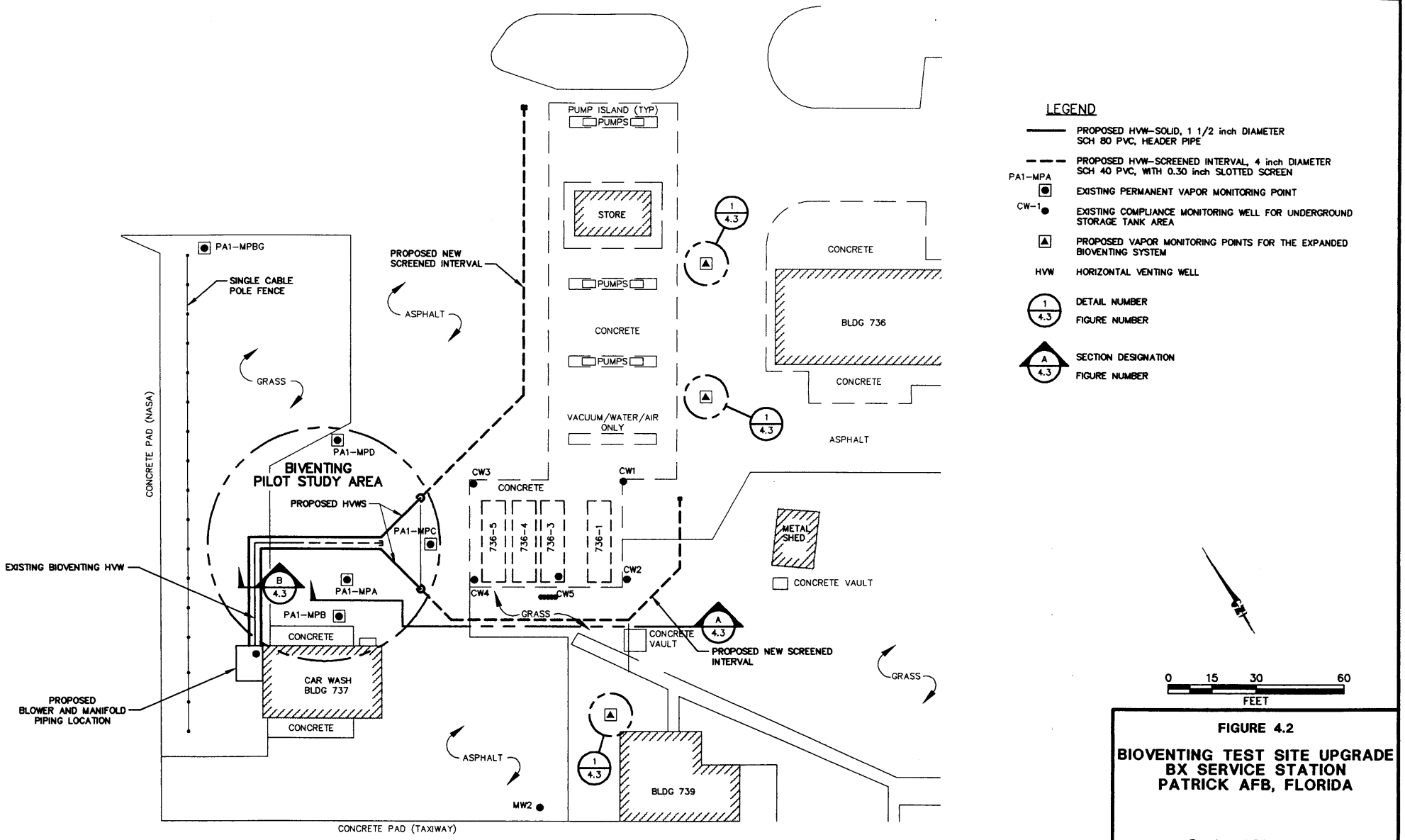


**FIGURE 4.2**

**BIOVENTING TEST SITE UPGRADE**
**BX SERVICE STATION**
**PATRICK AFB, FLORIDA**

Patrick AFB, Florida

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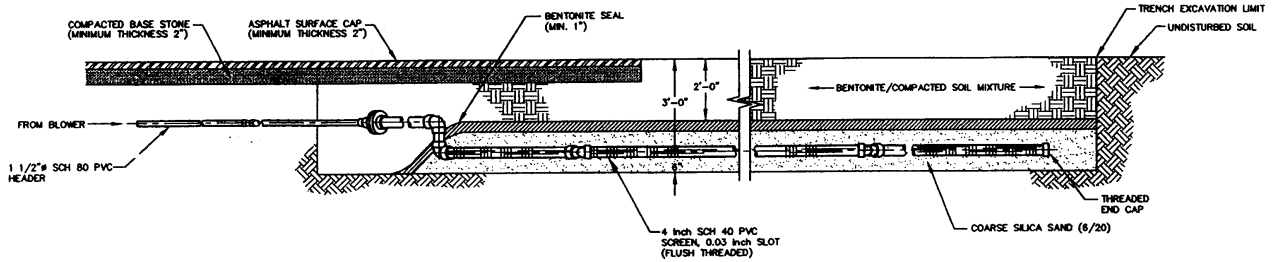
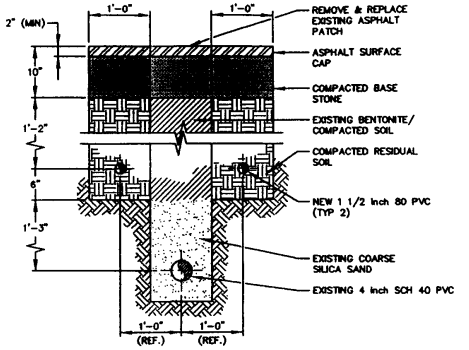
Denver, Colorado



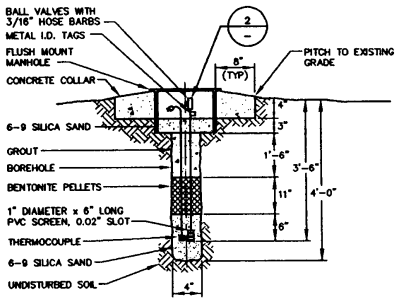

NOTE:

THE CONSTRUCTION IN THIS SECTION IS SIMILAR FOR EACH NEW SCREENED INTERVAL.

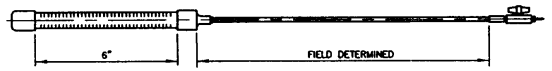
A/4.2 SECTION
NOT TO SCALE




B/4.2 SECTION
NOT TO SCALE




1/4.2 VAPOR MONITORING POINT CONSTRUCTION DETAIL
NOT TO SCALE




2/– VAPOR MONITORING DETAIL
NOT TO SCALE

LEGEND

1/4.3 DETAIL NUMBER
FIGURE NUMBER

**FIGURE 4.3**

**PROPOSED CONSTRUCTION DETAILS FOR THE HORIZONTAL VENTING WELLS AND VAPOR MONITORING POINTS AT THE BX SERVICE STATION SITE**

Patrick AFB, Florida

PARSONS ENGINEERING SCIENCE, INC.

Denver, Colorado

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The system upgrade will incorporate a total of approximately 245 feet of additional HVW screened interval consisting of Schedule 40, 4-inch-diameter polyvinyl chloride (PVC), with 0.030-inch slotted screen. All underground screened-interval piping will be installed 3 feet bgs and packed in a coarse 6/20 graded silica sand filter, 6 inches below and above the PVC screen. A 1-inch-thick bentonite seal will be placed above the filter pack, followed by a bentonite/compacted soil mixture installed in 1-foot lifts to ground surface and/or placement of an 8-inch compacted base stone and 2-inch minimum asphalt surface cap at grade (along the western side of the pump islands).

Air supply piping will be solid 1½"-diameter, Schedule 80 PVC that will be used as the conduit for the injected air to flow from the blower to the screened interval. Three additional vapor monitoring points will be installed across the site to ensure proper $O_2$ influence throughout the area of soil contamination. Existing compliance wells (CWs) around the UST tank farm area will serve as additional monitoring points for the contaminated area surrounding the USTs. All three HVWs will be manifolded to a single 1-horsepower regenerative blower located adjacent to the car wash (Bldg. 737). A separate throttling valve (manual) and pressure gauge will be installed for each HVW in order to adjust the air flow to each HVW. The blower and valving will be housed in a locked weatherproof enclosure for protection from the elements and for security purposes.

Based on data collected during the initial pilot test, a maximum injection rate of 10-15 SCFM at each HVW should be sufficient to supply oxygen to the remaining contaminated soils and sustain *in situ* fuel biodegradation. Since the majority of the site is covered by either asphalt or concrete, the potential for shortcircuiting the injected air has been significantly reduced or eliminated. The radius of oxygen influence around each HVW should extend a minimum of 40 feet at 10 SCFM, based on the data collected during the initial pilot testing.

## 4.3 CONSTRUCTION SCHEDULE

Following review and approval of the system upgrade work plan by AFCEE/ERT, Patrick AFB, and FDEP, field work will begin. The following schedule for the upgrade is contingent upon timely approval of this work plan:

| Event | Date |
|---|---|
| Draft Work Plan to AFCEE/ERT and Patrick AFB | March 14, 1995 |
| Final Work Plan to AFCEE/ERT, Patrick AFB, and FDEP | April 1, 1995 |
| Approval of Work Plan/ Notice to Proceed | May 1, 1995 |
| Begin Field Activities/ Construction of Expanded System | June 1, 1995 |
| Complete Construction/System Startup | June 26, 1995 |

## 4.4 SYSTEM OPERATION AND MONITORING

Following system installation, preparation of an operation and maintenance (O&M) plan, monitoring plan, and as-built system drawings will be prepared.

### 4.4.1 System Operation

At startup of the full-scale system, it will be necessary to optimize the air injection rate and to ensure proper operation of the blower system. Flow rate optimization is accomplished by gradually increasing the flow rate to each HVW until all vapor monitoring points reach a minimum oxygen concentration of approximately 10 percent. $O_2$ levels in excess of 10 percent at the outer VMPs may indicate that the volume of air passing through the soil exceeds the biological $O_2$ utilization. The blower will be checked to ensure that it is producing the required flow rate and pressure for air injection.

O&M requirements for bioventing systems are minimal. Regenerative blowers are virtually maintenance-free. The only recurring maintenance required on these units is a monthly check of the air filter, which is generally replaced when a pressure difference of 10 to 15 inches of water across the inlet filter is reached. The time period between filter changes is dependent on site conditions, and is typically every three to six months.

### 4.4.2 System Monitoring

Monitoring of the bioventing system will include weekly system checks of the blower operation, including outlet pressures, inlet vacuum, and exhaust temperature. Additionally, system performance monitoring will include a one-year visit to the site to conduct a comprehensive system check to ensure that $O_2$ continues to reach all VMPs in the contaminated soils, and to perform an *in situ* respiration (ISR) test at the VMPs and/or compliance wells to ensure that biodegradation is continuing at acceptable levels. Soil gas samples will also be collected from several VMPs and analyzed for BTEX and TVH using U.S. Environmental Protection Agency (EPA) laboratory method TO-3.

Confirmation of the contaminant removal rates is predicted from the data collected during the respiration tests ($O_2$ utilization rates), quantitative estimates of the long-term biodegradation rates (Kb), and decreases in soil gas concentrations.

After one year of operation, ISR tests will be performed by shutting off the blower, and monitoring $O_2$ uptake in the VMPs and CWs for approximately 72 hours to measure the rate at which $O_2$ decreases in the soil gas. This data will then be used to estimate the current biodegradation rates and to evaluate the progress of contaminant removal and system effectiveness. As the fuel in the soil is depleted, the respiration activity of the indigenous microorganisms is reduced, and slower $O_2$ utilization rates result. Once the oxygen utilization values in previously contaminated areas approach the values in uncontaminated (background) soil, confirmatory sampling and analysis will be conducted in the soil zones with the highest initial concentrations of TPH. The use of oxygen utilization and soil gas chemistry as screening indicators decreases the likelihood of premature and expensive soil sampling events.

The monitoring schedule for the full-scale system will be:

| Event | Frequency |
|---|---|
| Blower Vacuum/Pressures and Temperatures | Weekly |
| Respiration Testing | Annual |
| Soil Gas Sampling | Annual |
| Soil Sampling | As Required[a/] |

[a/] Soil sampling will be performed during confirmation closure sampling at project completion.

# SECTION 5

# KEY POINTS OF CONTACT

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# SECTION 6

# REFERENCES

O'Brien & Gere Engineers, Inc. 1990. Installation Restoration Program Phase II, Remedial Investigation/Feasibility Report Study, Stage 2, Patrick Air Force Base. Tampa, Florida. December.

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